University of Bahrain
College of Information technology
Department of Computer Engineering

Test (2)

Student Name
I.D. No.
Section

Course Title: Digital Logic
Course number: ITCE 250
Semester: 1
Academic Year: 2015/2016
Duration : 1 hour
Date: 9th December 2015

Read the following before you start:

1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only
4. **Use PEN only**

4- Use PEN only

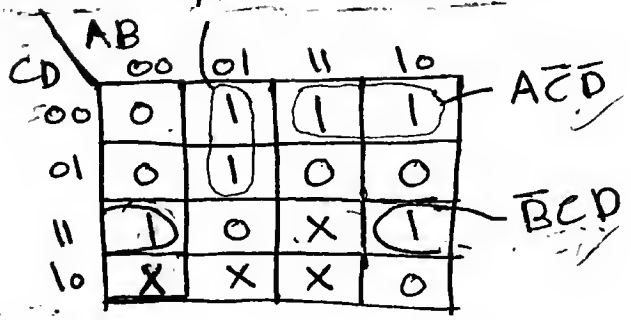
Question	Mark	Mark attained
1	16	16
2	16	16
3	16	16
4	16	16
5	16	16
Total	80	80

Question [1]: [16 mark]

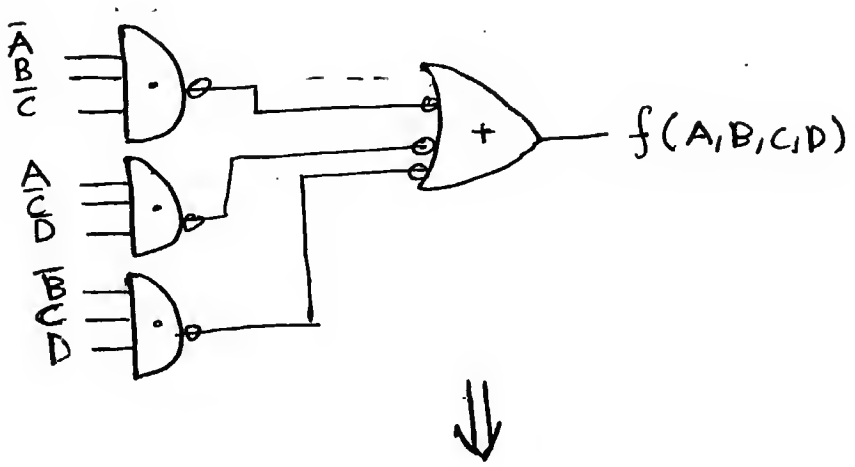
Realize the following function as a minimum two-level NAND gate circuit.

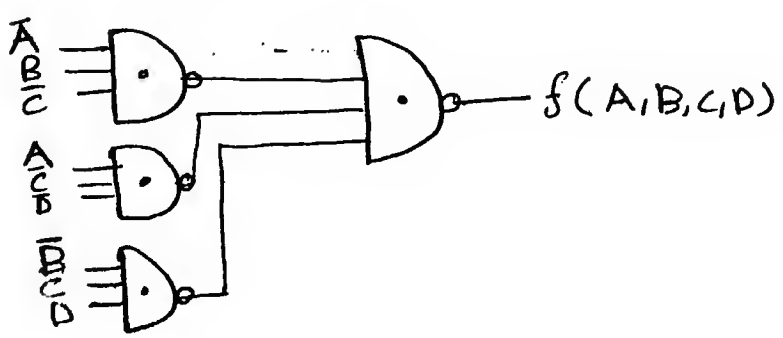
$$f(A,B,C,D) = \prod M(0,1,7,9,10,13).\prod D(2,6,14,15)$$

$f = \bar{A}B\bar{C}$ $f(A,B,C,D) = \sum m(3,4,5,8,11,12) + \sum d(2,6,14,15)$



$$f = \bar{A}B\bar{C} + A\bar{C}\bar{D} + \bar{B}CD$$



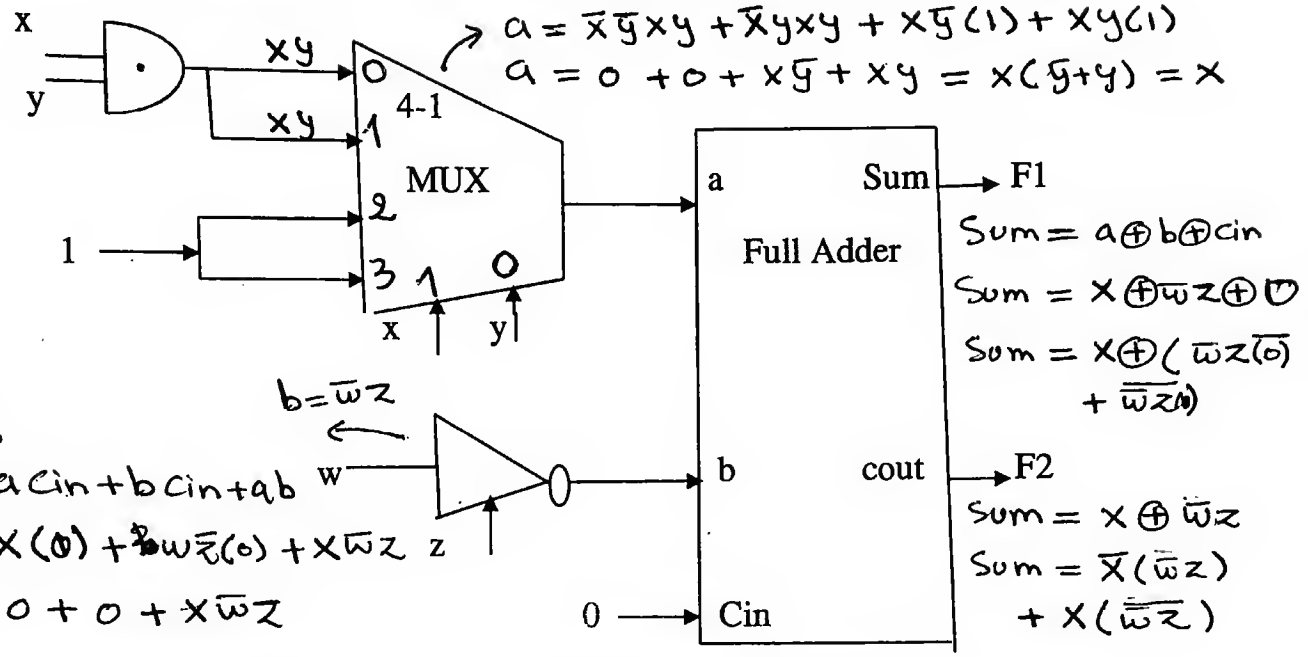


Question [2]: [16 Marks]

$a = m_0 I_0 + m_1 I_1 + m_2 I_2 + m_3 I_3$

$a = \bar{x}\bar{y}xy + \bar{x}yxy + x\bar{y}(1) + xy(1)$

$a = 0 + 0 + x\bar{y} + xy = x(\bar{y}+y) = x$



$b = \bar{w}z$

$b = \bar{w}z$

$Cout = a\,Cin + b\,Cin + ab$

$Cout = x(0) + \bar{w}z(0) + x\bar{w}z$

$Cout = 0 + 0 + x\bar{w}z$

$Sum = a \oplus b \oplus cin$

$Sum = x \oplus \bar{w}z \oplus 0$

$Sum = x \oplus (\bar{w}z(0) + \overline{\bar{w}z}(1))$

$Sum = x \oplus \bar{w}z$

$Sum = \bar{x}(\bar{w}z) + x(\overline{\bar{w}z})$

1- Derive the truth table and output equations of a Full-Adder.

2- Write the input equations of the given F-A.

3- Write the output equations of the given F-A as Sum of Products.

1)

a	b	cin	Cout	Sum
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Cout

bcin \ a	0	1
00	0	0
01	0	1
11	1	1
10	0	1

Sum

bcin \ a	0	1
00	0	1
01	1	0
11	0	1
10	1	0

← no simplification

$Cout = a\,Cin + a\,b + b\,Cin$

$Sum = \bar{a}\bar{b}cin + \bar{a}b\overline{cin} + a\bar{b}\overline{cin} + abcin$

$= \bar{a}(\bar{b}cin + b\overline{cin}) + a(\overline{\bar{b}\overline{cin} + bcin})$

$= \bar{a}(b \oplus cin) + a(\overline{b \oplus cin})$

$= a \oplus (b \oplus cin) = a \oplus b \oplus cin$

2) $a = x$, $b = \bar{w}z$, $Cin = 0$

3) $F_1 = x\bar{w}z + x(w + \bar{z}) = x\bar{w}z + xw + x\bar{z}$

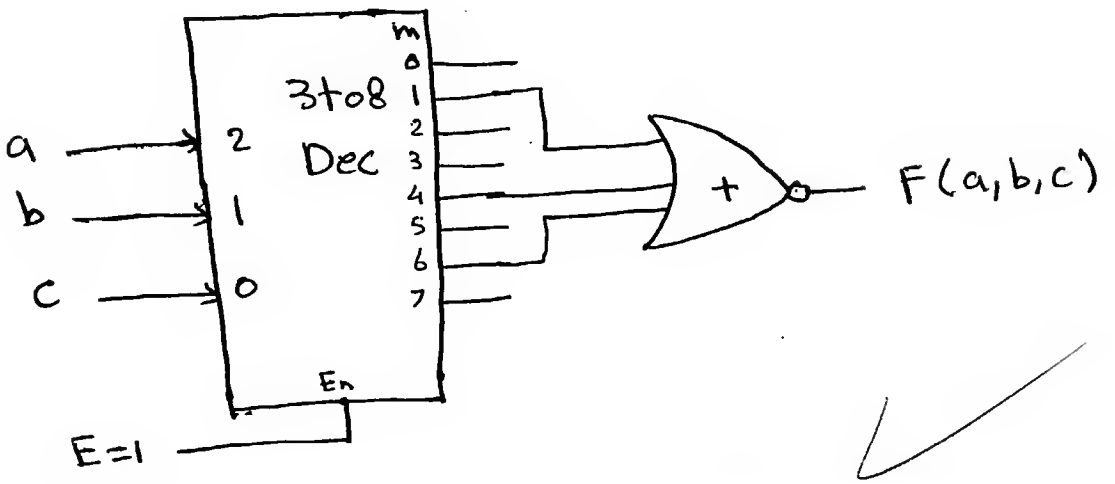
$F_2 = x\bar{w}z$

Question [3] : [16 marks]

a- Implement the function F with a 3-to-8 active high decoder and NOR extra gate.

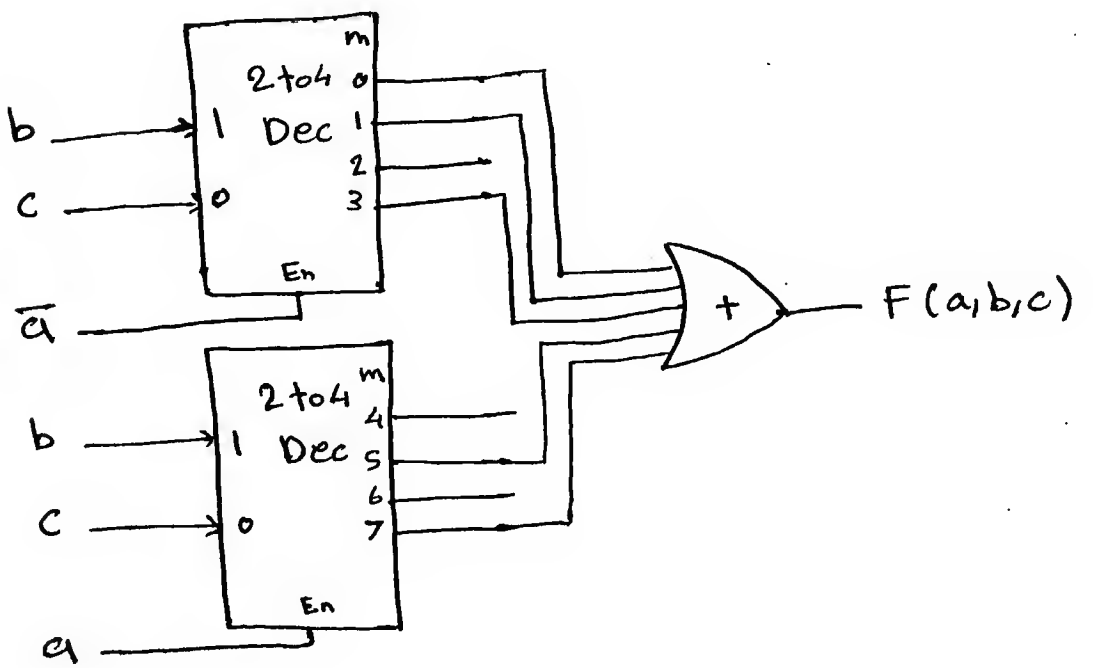
$$F(a,b,c) = \Sigma\, m\,(0,2,3,5,7)$$

$$F(a,b,c) = \Pi(1,4,6)$$



b- Implement the same function F with 2-to-4 decoders and an OR gate.

$$F(a,b,c) = \sum m(0,2,3,5,7)$$



Question [4] : [16 marks]

A ROM is used to store the values of the word Y. Where Y is equal to:
$Y = X^2$ X is a 3-bit number.

a- Give the ROM size in bits.

b- Draw the ROM structure by showing only the last line of the matrix array.

a)

$Y_{max} = (7^2)_{10} = (49)_{10}$

$X_{max} = (111)_2 = (7)_{10}$

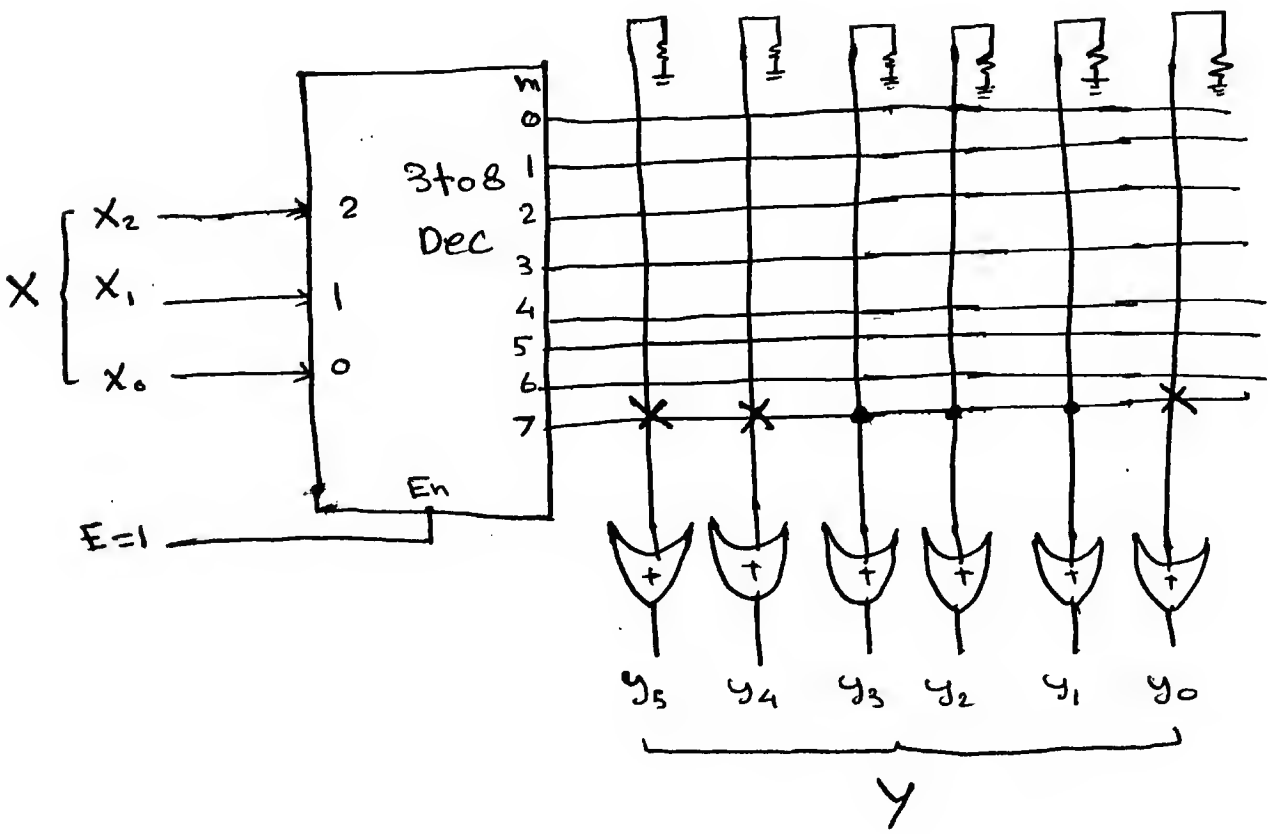
$32 + 16 = 48$

$(49)_{10} = (110001)_2$

$n = 3$

$m = 6$

ROM size $= 2^3 \times 6 = 8 \times 6 \Rightarrow$ 8 words x 6 bits



Question [5] : [16 marks]

Complete the following timing diagram for a J-K flip-flop shown in the figure. Label the different states of Q as one of the following (Set, Reset, PreN, ClrN, no Q change, Q change). Assume initial value Q=0.